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QCD material parameters at zero and non-zero chemical potential from the lattice

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Using an eighth-order Taylor expansion in baryon chemical potential, we recently obtained the (2+1)-flavor QCD equation of state (EoS) at non-zero conserved charge chemical potentials from the lattice. We focused on strangeness-neutral, isospin-symmetric QCD matter, which closely resembles the situation encountered in heavy-ion collision experiments. Using this EoS, we present here results on various QCD material parameters along lines of constant entropy per baryon number s/n_B. In particular we compute the specific heat, speed of sound, compressibility, and the thermal expansion coefficient along lines of constant s/n_B. We also present results at zero chemical potential for the isothermal speed of sound and isothermal compressibility. We show that in the vicinity of the crossover temperature, the speed of sound at fixed s/n_B has a well localized minimum or "soft point" at large s/n_B, which appears to vanish as s/n_B decreases. We show that this is consistent with hadron resonance gas model calculations at low temperature and reflects the increasing importance of the baryon sector at low temperature. A similar behavior is found for the isothermal speed of sound, which decreases monotonically at low temperature for all s/n_B. Furthermore, we show that in the entire range of s/n_B relevant for the beam energy scan at RHIC, the specific heat, compressibility, and thermal expansion coefficient show no indication for an approach to critical behavior that one would expect close to a possibly existing critical endpoint.

Category

Theory

Collaboration (if applicable)

HotQCD collaboration

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